UNUSUAL WASTE FORMS FROM FORT ST. VRAIN

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ABSTRACT

Radioactive disposal at Fort St. Vrain has been accomplished with full compliance with all regulations in spite of unique differences in plant design. These differences lead to unique waste forms and radionuclide mixtures that have prevented experience gained at light-water reactors from being directly applied to waste at Fort St. Vrain. The work presented here describes the unique plant features, what waste has been shipped and the waste shipping campaign to be completed in 1987.

INTRODUCTION

Fort St. Vrain is a 842-MW(th) high-temperature gas-cooled reactor (HTGR) located near Platteville, Colorado. The nuclear steam supply system was designed by Gulf General Atomics and commenced power operation in January of 1974. Its nuclear core consists of 1482 hexagonal graphite fuel blocks surrounded by 2188 hexagonal reflector elements housed in a prestressed concrete reactor vessel. The fuel itself consists of fully enriched U-235 and fertile thorium beads encased in a multi-layered carbon coating and sealed within holes drilled in the graphite fuel blocks. Helium coolant flows through the core at 3.4 million pounds per hour and a pressure of about 700 psia. Inlet and outlet temperatures are 762 F and 1482 F respectively at full power. Because of the high-temperature coolant, the thermal efficiency yields a net electrical output of 330 MW.

The differences in design from other nuclear plants in the US leads to unique advantages for the HTGR in several areas of operational significance. Because most of the activated corrosion products and fission products normally found in light water reactors are not soluble or otherwise readily transportable by the helium coolant within the primary system, the radiation fields and radioactive contamination levels are much less than are found at other plants. This leads to much lower occupational radiation exposures and radioactive waste production. These differences in design also lead to unique waste forms and distributions of radioactivity. Regulatory compliance must be assured for these differences without the benefit of the industry experience and practices available to other nuclear power plant operators.

Waste Sources

The reactor coolant is purified in a purification train when it passes through dryers, charcoal filters, and a bed of titanium sponge. Water removed in this system is processed by ion exchange. Dry active waste, waste oil, and radwaste resin from processing floor and equipment drains are all produced in manners similar to light-water reactors. Activated components and other material exposed to the core also act as sources of low-level radioactive waste.

Sulfur-35 and tritium are the only nuclides which are transported by the helium coolant to any appreciable extent. Both of these nuclides pose only negligible risks because they do not emit any gamma rays and have relatively short half lives. The S-35 (from neutron activation of the small amounts of sulfur impurity in the graphite) comprises the predominant activity in the radioactive waste after short decay times but decays to lower levels relatively quickly. Small amounts of fission products are transported via their gaseous precursors. Activated corrosion products and fission products are also transported to a limited extent as particulate matter. Radiation levels and contamination levels are generally several orders of magnitude less than that found at light water reactors (LWRs).

Experience

From initial criticality through December 1986, a total of only about 4000 cubic feet of radioactive waste was shipped from Fort St. Vrain. This time period includes three refueling outages and represents a total power generation of about ten million megawatt hours (thermal). The total activity of this waste was 420 curies, 400 of which were contained in only 26 cubic feet of irradiated reactor components. Table I summarizes the total volumes and activities of this waste.

TABLE I

Fort St. Vrain Radwaste from 12 Years of Operation

Waste Type	Activity (Curies)	Volume, ft^3
DAW	2.5	1521
Resin	12.8	1608
Oil	0.7	625
Shutdown Spheres	4.3	81
Irradiated Components	400	26
Misc.	0.02	22
Total	420	3883

The log mean contact dose rate of these drums was only 0.22 mR/h, and three-fourths of them had a contact dose rate of less than one mR/h. The distribution of the contact dose rate is shown in Fig. 1 and summarized in Table II.

TABLE II

Summary of Drums Shipped

	DAW	Resin	Oil	Shutdown Spheres	Total
Number of Drums	207	219	85	11	522
Mean, mR/h	6.3	0.1	0.06	8.4	2.7
Log Mean, mR/h	1.13	0.06	0.05	5.2	0.22
Maximum, mR/h	140	2.2	0.23	26	140
Minimum, mR/h	0.02	0.02	0.2	1.0	0.02

This waste was shipped in about 500 fifty-five-gallon drums and two small liners. This waste generation rate corresponds to a small fraction of that which would have been produced by a typical LWR in terms of both activity and volume.

Future Waste Shipments

The waste disposal campaign in 1987 will consist exclusively of the shipment of reactor irradiated components since only a small amount of resin and dry active waste have been accumulated since the 1985 campaign. These activated components consist of 140 graphite reflector blocks and two metal orifice valves. All of this waste will be Class A unstable waste according to the criteria of 10CFR61. The graphite reflector blocks would probably qualify as a stable waste form under 10CFR61, but since their activity levels do not exceed Class A, no ruling has been sought from the regulatory or burial site bodies concerning the stability of this unique waste form.

The graphite reflector blocks posed an interesting and difficult sampling and classification problem. Because of the neutron flux in the reflector blocks and their exposure to reactor coolant, their activity levels are the sum of both activation products and surface contamination. For this reason, sampling was accomplished by drilling several holes in three selected reflector blocks, collecting the fines from drilling, and submitting this powder to on-site and off-site laboratories for analyses. The results from these analyses will be used for waste-class and dose-to-curie determinations for waste shipment and disposal.

In summary, waste disposal at Fort St. Vrain has progressed without the benefit of an established industry experience base. The disposal of this waste has, however, been expedited by the low activity levels and production rates inherent in the HTGR design.

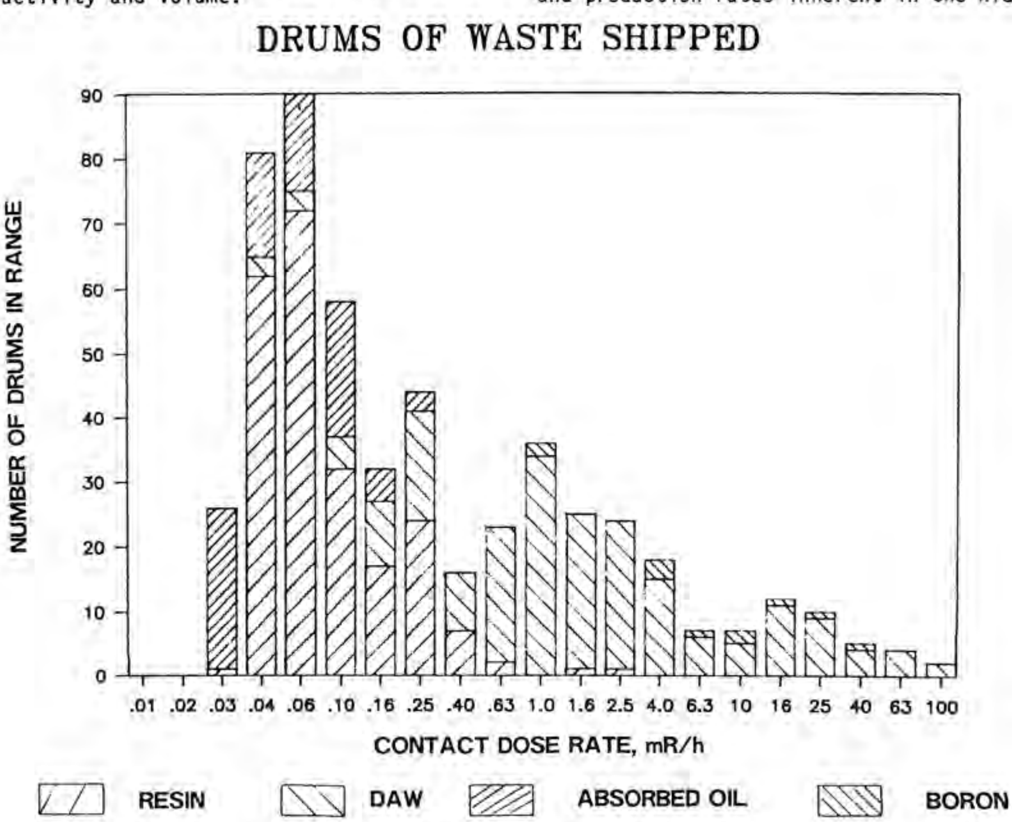

Fig. 1. Distribution of Contact Dose Rates.